NISTIR 6030

THIRTEENTH MEETING OF THE UJNR PANEL ON FIRE RESEARCH AND SAFETY, MARCH 13-20, 1996

VOLUME 1

Kellie Ann Beall, Editor

June 1997
Building and Fire Research Laboratory
National Institute of Standards and Technology
Gaithersburg, MD 20899

U.S. Department of Commerce
William M. Daley, *Secretary*
Technology Administration
Gary R. Bachula, *Acting Under Secretary for Technology*
National Institute of Standards and Technology
Robert E. Hebner, *Acting Director*

PROGRESS REPORT ON PERFORMANCE-BASED FIRE SAFETY DESIGN METHOD

Takeyoshi TANAKA
Building Research Institute, Ministry of Construction
1 Tatehara, Tsukuba-shi, Ibaraki-ken 305, JAPAN

1. FIRE SAFETY DESIGN METHOD

A subcommittee of MOC's 5 year project: "Development of Evaluation Method of Fire Performance of Building Elements (1993 - 1997)" is undertaking the development and refinement of the performance-based design method of buildings jointly with the AIJ (Architectural Institute of Japan) Fire safety design method committee.

The current stage of the development is about as follows:

(1) It is the first step for developing performance based fire safety design method to identify and define the fundamental requirements (Objectives) for fire safety of buildings. These have been completed. The requirements for prevention of urban fire is included as well as the requirements for fire safety of individual buildings.

(2) The technical standards for verification of compliance have been developed for most of the requirements, but the standards for some objectives remains to be undeveloped. Currently stress is placed on the development of performance oriented criteria for means of escape alternative to the prescriptive requirements in the existing building codes:

(a) The requirement of "two or more exits" from a room was considered from the viewpoint of expected number of occupants unable to escape due to the onset of fire in front of exits, and the criterion alternative to the existing requirement was established.[1]

(b) The requirements on "common path length" and "single stairway (exemption of two or more stairways)" were also considered from the viewpoint of expected number of occupants unable to escape due to the obstruction of corridor and stairway by fire, and the criterion alternative to the existing requirement was established.[2]

(c) The method for assessing the degree of legibility of escape route is explored using computer simulations from the viewpoint of the expected distance that evacuees who are unfamiliar with the building cover before they arrive at one of the exits. The practical criterion for use in actual design practice is still under consideration. [3]

(3) Design Fire

The effect of the consumption of oxygen on the design fire for compartment fire was studied, and the previous design fire, which consists of the initially growing and the threshold heat release rates were revised. A sudden decrease of the transient heat release rate may appear in the new design fire depending on the conditions of initial air capacity and ventilation of fire room.

2. FIRE SAFETY ENGINEERING TOOLS

For the verification of compliance with requirements based on the performance standards, which are usually prescribed in terms of safety criteria and design fire, fire safety engineering tools for estimating the effect of fire behaviors are indispensable. Considering the difficulty in validating computer fire models, analytical or hand calculation methods should be developed as many as possible. Such calculation method, even though limited to simple conditions, will be useful in many practical applications.

The recent activities addressing the development of the simple calculation methods are as follows:

(1) Simple formula for ventilation controlled room fire temperature
McCaffrey-Quintiere correlation was extended to predict the temperatures of the room of origin under ventilation controlled fire and the connected corridor.[4]

(2) Heat of combustion of excess fuel in widow flames
The experimental investigations were carried out for the validity of empirical correlation on the mass burning rate of fully developed fire for different fuel conditions in order to estimate the total heat of window flames, which is important for assessing the hazards of upper floor fire spread.[5]

(3) Temperature of smoke and pressure in cavity fire
Behavior of smoke ejected into cavity like spaces in buildings cannot be predicted by zone fire models and using field model takes painful time. The experimental correlation of temperature of plume and the pressure difference induced in the space with heat release rate, dimensions of cavity space and bottom opening size has been developed.[6]

(4) Time of initial ascent of plume front
The time that the rising plume front arrives at a given height right after the ignition of the source was experimentally investigated in the open air and in the shafts and the correlation of the time and the heat release rate and height has been developed.[7]

(5) Practical method for predicting evacuation
Computer models for predicting evacuation of occupants in fire exist but practical methods for assessing the evacuation time and the magnitude of queue in front of exits are necessary. The development of such methods is still under stage of consideration.

REFERENCES

[1]Tanaka, Hagiwara & Mimura: A Consideration on Required Number of Exits in a Room
[2]Hagiwara, Tanaka & Mimura: A Consideration on Common Path Length and Single Stairway
[3]Ebihara: Assessment of Clarity of Egress Route in Buildings
[4]Tanaka, Sato & Wakamatsu: Simple Formula for Predicting Ventilation Controlled Room Fires
[5]Ohmiya, Tanaka & Wakamatsu: A Compartment Fire Model in view of Predicting Fire Spread by External Flames
[6]Tanaka, Fukuda & Wakamatsu: Experiments on Smoke Movement in Cavity Space
[7]Fujita, Tanaka & Wakamatsu: Time of Ascent of Fire Plume Front, under preparation for AIJ Buletin.
(Note: References[1] - [6] will be presented in this UJNR joint meetings)

Discussion

James Quintiere: I will be interested in your paper using our simple method because the method was used for controlled records and support data. My question is one on clarification. What do you mean by cavity space?

Takeyoshi Tanaka: What we call cavity space is the space integrated into buildings which have no roof.

James Quintiere: One of the things you mentioned is that you need to define performance. I wanted to ask whether this task group is going to look at specific installations, for example, and suggest how one can arrive at what performance would provide safety?